

WHAT IS CLAIMED IS:

1. An antenna apparatus comprising:

a feed point;

5 a first linear antenna element which has one end connected to the feed point;

a second linear antenna element which has one end connected to the other end of the first linear antenna element;

10 a third linear antenna element which has one end connected to the other end of the first linear antenna element;

a fourth linear antenna element which has one end connected to the other end of the second linear antenna element; and

15 a connection element which connects the other end of the second linear antenna element and a ground terminal,

20 wherein a sum of lengths of the first, second, and fourth linear antenna elements is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first, second, and fourth linear antenna elements, a sum of lengths of the second, third, and fourth linear antenna elements is  $1/2$  a wavelength corresponding to a parallel-resonance frequency of the second, third, and  
25 fourth linear antenna elements,

a sum of lengths of the first and third linear antenna elements is  $1/4$  a wavelength corresponding to a

series-resonance frequency of the first and third linear antenna elements, and

the parallel-resonance frequency is higher than a frequency of the series-resonance frequency of the first, second, and fourth linear antenna elements and lower than the series-resonance frequency of the first and third linear antenna elements.

2. An apparatus according to claim 1, wherein the third and fourth linear antenna elements are arranged parallel to each other.

3. An apparatus according to claim 1, wherein the first, second, third, and fourth linear antenna elements include wire elements, and

the connection element includes a planar element.

4. An apparatus according to claim 1, wherein the first, second, third, and fourth linear antenna elements and the connection element include wire elements.

5. An apparatus according to claim 1, wherein the first, second, third, and fourth linear antenna elements and the connection element include ribbon elements.

6. A radio apparatus comprising:

an antenna apparatus comprising a feed point, a first linear antenna element which has one end connected to the feed point, a second linear antenna element which has one end connected to the other end of

the first linear antenna element, a third linear antenna element which has one end connected to the other end of the first linear antenna element, a fourth linear antenna element which has one end connected to the other end of the second linear antenna element, and a connection element which connects the other end of the second linear antenna element and a ground terminal, wherein a sum of lengths of the first, second, and fourth linear antenna elements is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first, second, and fourth linear antenna elements, a sum of lengths of the second, third, and fourth linear antenna elements is  $1/2$  a wavelength corresponding to a parallel-resonance frequency of the second, third, and fourth linear antenna elements, a sum of lengths of the first and third linear antenna elements is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first and third linear antenna elements, and the parallel-resonance frequency is higher than a frequency of the series-resonance frequency of the first, second, and fourth linear antenna elements and lower than the series-resonance frequency of the first and third linear antenna elements; and

a radio circuit which is connected to the feed point and transmits and receives a radio wave via the antenna comprised the first, second, third,

and fourth linear antenna elements.

7. An antenna apparatus comprising:

a feed point;

5 a first linear antenna element which has one end  
connected to the feed point;

a second linear antenna element which has one end  
connected to the other end of the first linear antenna  
element;

10 a third linear antenna element which has one end  
connected to the other end of the first linear antenna  
element and is arranged on the same plane as the second  
linear antenna element; and

15 a connection element which connects the other end  
of the first linear antenna element and a ground  
terminal,

wherein a sum of lengths of the first and third  
linear antenna elements is  $1/4$  a wavelength  
corresponding to a series-resonance frequency  
of the first and third linear antenna elements,

20 a sum of lengths of the second and third linear  
antenna elements is  $1/2$  a wavelength corresponding to a  
parallel-resonance frequency of the second and third  
linear antenna elements,

25 a sum of lengths of the first and second linear  
antenna elements is  $1/4$  a wavelength corresponding to a  
series-resonance frequency of the first and second  
linear antenna elements, and

the parallel-resonance frequency is higher than the series-resonance frequency of the first and third linear antenna elements and lower than the series-resonance frequency of the first and second linear antenna elements.

8. An apparatus according to claim 6, wherein the first, second, and third linear antenna elements include wire antenna elements, and the connection element includes a planar antenna element.

9. An apparatus according to claim 6, wherein the first, second, and third linear antenna elements and the connection element include wire antenna elements.

10. An apparatus according to claim 6, wherein the first, second, and third linear antenna elements and the connection element include ribbon antenna elements.

11. A radio apparatus comprising:

an antenna apparatus comprising a feed point, a first linear antenna element which has one end connected to the feed point, a second linear antenna element which has one end connected to the other end of the first linear antenna element, a third linear antenna element which has one end connected to the other end of the first linear antenna element and is arranged on the same plane as the second linear antenna element, and a connection element which connects the

other end of the first linear antenna element and a ground terminal, wherein a sum of lengths of the first and third linear antenna elements is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first and third linear antenna elements,

5 a sum of lengths of the second and third linear antenna elements is  $1/2$  a wavelength corresponding to a parallel-resonance frequency of the second and third linear antenna elements, a sum of lengths of the first and second linear antenna elements is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first and second linear antenna elements, and the parallel-resonance frequency is higher than the series-resonance frequency of the first and third linear antenna elements and lower than the series-resonance frequency of the first and second linear antenna elements; and

10 a radio circuit which is connected to the feed point and transmits and receives a radio wave via the antenna comprised the first, second, and third linear antenna elements.

12. An antenna apparatus comprising:

a feed point;

25 a first linear antenna element which has one end connected to the feed point;

a second linear antenna element which has one end connected to the other end of the first linear antenna

element;

a third linear antenna element which has one end connected to the other end of the second linear antenna element; and

5 a connection element which connects the other end of the second linear antenna element and a ground terminal,

wherein a sum of lengths of the first, second, and third linear antenna elements is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first, second, and third linear antenna elements,

10 a sum of lengths of the second and third linear antenna elements is  $1/2$  a wavelength corresponding to a parallel-resonance frequency of the second and third linear antenna elements,

a length of the first linear antenna element is  $1/4$  a wavelength corresponding to a series-resonance frequency of the first linear antenna element, and

15 the parallel-resonance frequency is higher than the series-resonance frequency of the first, second, and third linear antenna elements and lower than the series-resonance frequency of the first linear antenna element.

13. An apparatus according to claim 10, wherein  
25 the first, second, and third linear antenna elements include wire antenna elements, and

the connection element includes a planar antenna

element.

14. An apparatus according to claim 10, wherein  
the first, second, and third linear antenna  
elements and the connection element include wire  
5 antenna elements.

15. An apparatus according to claim 10, wherein  
the first, second, and third linear antenna  
elements and the connection element include ribbon  
antenna elements.

10 16. A radio apparatus comprising:

an antenna apparatus comprising a feed point, a  
first linear antenna element which has one end  
connected to the feed point, a second linear antenna  
element which has one end connected to the other end of  
15 the first linear antenna element, a third linear  
antenna element which has one end connected to the  
other end of the first linear antenna element, a fourth  
linear antenna element which has one end connected to  
the other end of the first linear antenna element, a  
20 fifth linear antenna element which has one end  
connected to the other end of the second linear antenna  
element, a sixth linear antenna element which has one  
end connected to the other end of the second linear  
antenna element, and a connection element which  
25 connects the other end of the second linear antenna  
element and a ground terminal, in which an axis of the  
first linear antenna element coincides with an axis of



the second linear antenna element, a division line which halves an angle defined by the third and fourth linear antenna elements and a division line which halves an angle defined by the fifth and sixth linear antenna elements are directed to the same direction, the lengths of the third and fourth linear antenna elements are equal to each other, and the lengths of the fifth and sixth linear antenna elements are equal to each other; and

10           a radio circuit which is connected to the feed point and transmits and receives a radio wave via the antenna comprised the first, second, third, fourth, fifth, and sixth linear antenna elements.

17. An antenna apparatus comprising:

15           a feed point;

          a first linear antenna element which has one end connected to the feed point;

          a second linear antenna element which has one end connected to the other end of the first linear antenna element;

20           a third linear antenna element which has one end connected to the other end of the first linear antenna element;

          a fourth linear antenna element which has one end connected to the other end of the first linear antenna element;

          a fifth linear antenna element which has one end

connected to the other end of the second linear antenna element;

5 a sixth linear antenna element which has one end connected to the other end of the second linear antenna element; and

a connection element which connects the other end of the second linear antenna element and a ground terminal,

10 in which an axis of the first linear antenna element coincides with an axis of the second linear antenna element,

a division line which halves an angle defined by the third and fourth linear antenna elements and a division line which halves an angle defined by the  
15 fifth and sixth linear antenna elements are directed to the same direction,

the lengths of the third and fourth linear antenna elements are equal to each other, and

20 the lengths of the fifth and sixth linear antenna elements are equal to each other.

18. An apparatus according to claim 14, wherein  
the sum of the lengths of the first, second, and  
fifth linear antenna elements is  $1/4$  the wavelength  
corresponding to a series-resonance frequency of the  
25 first, second, and fifth linear antenna elements,

the sum of the lengths of the first, second, and sixth linear antenna elements is  $1/4$  the wavelength

corresponding to a series-resonance frequency of the first, second, and sixth linear antenna elements,

the sum of the lengths of the second, third, and fifth linear antenna elements is  $1/4$  the wavelength

5 corresponding to a parallel-resonance frequency of the second, third, and fifth linear antenna elements, and

the sum of the lengths of the second, fourth, and sixth linear antenna elements is  $1/2$  the wavelength

10 corresponding to a parallel-resonance frequency of the second, fourth, and sixth linear antenna elements.

19. An apparatus according to claim 14, wherein

the third and fifth linear antenna elements are arranged parallel to each other, and

15 the fourth and sixth linear antenna elements are arranged parallel to each other.

20. An apparatus according to claim 14, wherein

the third and fourth linear antenna elements are arranged on the same plane, and

20 the fifth and sixth linear antenna elements are arranged on the same plane different from the plane on which the third and fourth linear antenna elements are arranged.

21. An apparatus according to claim 14, wherein

25 the first, second, third, fourth, fifth, and sixth linear antenna elements include wire antenna elements, and the connection element includes a planar antenna element.

22. An apparatus according to claim 14, wherein the first, second, third, fourth, fifth, and sixth linear antenna elements and the connection element include wire antenna elements.

5        23. An apparatus according to claim 14, wherein the first, second, third, fourth, fifth, and sixth linear antenna elements and the connection element include ribbon antenna elements.